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PRINCIPAL INVESTIGATOR: Barbara Abrams, Ph.D.

CONTRACTING ORGANIZATION: University of California at Berkeley
Berkeley, California 94720-5940

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Barbara Abrams, Ph.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of California at Berkeley
Berkeley, California 94720-5940

E-Mail: Barbara@socrates.berkeley.edu

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We have completed recruitment, data collection and data entry for this study group of new mothers attending the well-baby clinic at the Naval Medical Center, San Diego. We enrolled more than 2500 eligible women and obtained essential data from 2433 of them. Approximately 20% of the study participants are active duty women.

Results so far suggest some social, demographic and behavioral risk factors that appear related to increased postpartum weight retention in both active duty and dependent mothers. In particular, high weight gain during the first trimester of pregnancy and history of weight cycling appear to be risk factors for high postpartum weight retention. In addition, history of weight cycling contributes to excessive pregnancy weight gain, and may be an important indicator of women at risk for subsequent obesity after pregnancy.

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Postpartum Maternal Weight Changes: Implications for Military Women

INTRODUCTION

Maintaining physical readiness to meet demands of combat conditions is of utmost importance for active duty military personnel. All branches of the military assess body size as a major indicator of fitness. During the last 20 years, the number of women on active duty in all services increased almost five-fold, from 2.5% in 1973 to 11.5% in 1992. As growing numbers of women of childbearing age enter active duty military service, the numbers of pregnancies among female military personnel will also increase. Thus, understanding the impact of pregnancy on subsequent fitness of postpartum active duty women becomes imperative.

During an average successful human pregnancy, the mother increases her body weight by 20% or more. There is strong and consistent scientific evidence that this weight gain plays an important role in ensuring a healthy infant. However, relatively few studies have addressed maternal weight loss after delivery and none have been conducted in populations of military women. Nonetheless, military women are required to return to active duty 6 weeks after delivery, in good physical condition and in uniform. Although studies in civilian populations suggest that it may take as long as a year to return to prepregnant body size, (1, 2) women in the military are expected to achieve weight and fitness standards much sooner than this: in the Navy and Marine Corps they are required to achieve weight and fitness standards within 6 months after delivery; the Army exempts women from standards for "the period of convalescent leave after birth," and the Air Force expects compliance by 3 months after delivery. Rehabilitation (comprised of a low fat diet and exercise regime) is required of women who fail to meet these standards, and if women remain outside acceptable ranges, they are subject to discipline or dismissal.

Yet, despite a body of previous research, the "normal" pattern of postpartum weight gain and risk factors for postpartum weight retention remain poorly understood. Without a clear understanding of the cause of weight retention, it is impossible to design effective strategies for intervention.

Background

Maternal weight retention after birth A 1990 Institute of Medicine (IOM) report concluded that, after considering weight increases due to age and given an average maternal weight gain during pregnancy, average permanent weight retention is about 1 kg per pregnancy. (5) Recent studies are consistent with this estimate, reporting the average mother retains about 1.5 kg (3.3 pounds) of her pregnancy weight gain (1,2,6), although several report values as high as 3.8 kg (8.4 lb) at one year postpartum. (7,8) A comparison of 18-30 year old women who had been pregnant with those who had not over a 5 year period concluded that primaparas gained, on average, 2-3 kg more weight than nulliparas. (9)

However, focusing on the average weight retention can obscure important differences in subgroups. For example, median weight retention at 10-18 months after delivery was only 3.4 lb in the 1988 National Maternal Infant Health Survey (NMIHS), a national sample of 2845 US. women, but 25% of white women and 40% of black women retained more than 9 lb. (6)

Similarly, in a study of 1423 Swedish women, after controlling for weight change with age, average weight retention at 1 year postpartum was only 0.5 kg (1 lb) but the frequency of overweight women increased from 13% before pregnancy to 21% postpartum. (1) Thus, studies of maternal weight retention must assess not only the experience of average women, but also provide information on subgroups, for example, by race, prepregnant size, or breast-feeding status.

Because of fluid adjustments that occur immediately after birth, most women lose weight quickly until two weeks postpartum, and then the rate of weight loss levels off. (5) Among mostly middle class white mothers who delivered in Wisconsin, fewer than one-fourth had returned to their pre-pregnancy weights by 6 weeks postpartum, (2) and mean weight retention at 6 weeks was 4.5 kg in 400 Illinois women. (8) Furthermore, in the Wisconsin study, only 37% of the women had returned to their pre-pregnancy weight by 6 months after delivery. These data indicate that maternal weight is not lost immediately after pregnancy, and additional research is needed to describe both average loss and its distribution throughout the first year after delivery.

The strongest factor contributing to weight changes postpartum is prenatal weight gain. (1,2,5,6,8,10-13) For example, our multivariate study of the 1988 NMIHS found that women with normal pre-pregnancy body size who gained above 35 pounds (the upper limit of the current IOM recommendation for prenatal weight gain in normal weight women) were over twice as likely to retain 20 or more pounds postpartum than those who gained within the IOM guideline of 25-35 pounds. (11) This increased risk was present for both white and black mothers and persisted after adjustment for various maternal characteristics. Postpartum weight retention in this population was relatively low among white mothers who gained within the IOM recommendation, suggesting that current prenatal weight gain guidelines may provide some protection against postpartum obesity for these women. (6,11)

Since black mothers, on average, gain less weight during pregnancy than white mothers, (5) one would expect that black mothers would retain less after delivery. However, data from the 1988 NMIHS survey indicate that black mothers retain on average more weight than white mothers. (6) This difference persists regardless of pre-pregnancy body size or prenatal weight gain. Furthermore, in our multivariate study of NMIHS participants with normal pre-pregnancy weight-for-height, black mothers were over twice as likely to retain 20 or more pounds postpartum than white mothers. (11) This difference remained after adjustment for maternal age, parity, prenatal weight gain, infant birth weight, height, pre-pregnancy body size, marital status, and social class. Other recent studies reported similar findings.(9,13) We identified no published data on postpartum weight change in mothers who were Hispanic, Asian or other races. Additional research is clearly needed to determine factors that influence maternal weight loss after delivery by race.

Encouraging individuals to increase their physical activity is a hallmark of weight management, but little is known about the impact of recreational or occupational physical activity in relation to maternal weight loss after delivery.(13) In a Swedish study, women who retained excess weight postpartum reported low levels of recreational physical activity during the year after birth, and increased physical activity was correlated significantly with postpartum weight loss.(14) In another small study of exclusively breast feeding women, maternal weight

loss did not differ for mothers who undertook regular aerobic exercise between 6 and 18 weeks postpartum, compared to those who did not, although exercising mothers became more physically fit than their non-exercising counterparts.(15)

Little is known about the prevalence or impact of dieting during the postpartum period, for either lactating or non-lactating mothers.(14) Results of a Swedish study suggested that intentional dieting was associated with increased weight loss, while certain dietary practices (e.g., increased meal size, increased snacking, meal skipping) were associated with excessive weight retention.(15) Dieting is of special concern to women who breast feed, because while there appears to be little or no relationship between moderate changes in energy intake and milk volume, there is some evidence that a threshold exists under which the quality and quantity of breast milk may be compromised.(14)

Cigarette smoking, which is a major risk factor for poor health in general and during pregnancy, is protective against excessive weight retention postpartum.(1,2) In fact, the highest risk of weight retention may occur in mothers who quit smoking during pregnancy and do not resume postpartum.(1) This observed benefit of smoking does not offset the toxic effects of cigarettes on the health of both the mother and her baby.

New mothers are commonly told that breast-feeding will accelerate their weight loss after birth. The basis of this advice is the assumption that fat stores gained during pregnancy are mobilized to subsidize the energy cost of lactating. However, while some studies suggest that breast-feeding women lose weight faster than bottle-feeding women, many do not. (2, 3, 8, 10, 11, 16-18)

Wider variations in weight change postpartum are observed in women who begin pregnancy overweight than in lighter women.(1,10) There is also evidence that women with a history of weight cycling and dieting are more likely to retain excessive amounts of weight after pregnancy.(1, 19)

There is consistent evidence that women with lower income and lower education may have an increased risk of retaining more weight postpartum than women with higher socioeconomic indicators.(8,11) It is likely that socioeconomic differences are based on lifestyle behaviors and environmental circumstances. Other important risk factors for excessive postpartum weight retention include maternal age, parity, interpartum interval and maternal work outside the home. For these variables, study results are not consistent, suggesting the need for additional research.(20) Furthermore, the importance of adequate help and social support during the year after delivery to maternal weight changes, especially for those mothers working outside the home, has not been studied.

As previously discussed, maternal weight gain during pregnancy is an important risk factor for excessive postpartum weight retention. This implies that restriction of maternal weight gain during pregnancy might be a useful strategy to promote a quicker maternal postpartum weight loss. However, maternal weight gain during pregnancy is an important determinant of fetal size at delivery, which in turn is the most important predictor of survival and health of the newborn.(5) Reflecting this relationship, current recommendations for maternal weight gain

during pregnancy are higher than ever before, especially for women who begin pregnancy at or below ideal weight for height.(5) Thus, although the major focus of this study is maternal weight after delivery, the birth weight of the infant must also be considered.(21) Furthermore, the pattern of maternal weight gain during pregnancy may play a more important role in fetal outcome than the total amount, although only a few studies have examined this issue. We have recently published a multivariate analysis of almost 3000 white women which suggests that, even when total maternal weight gain at delivery is held constant, a low maternal weight gain during the second trimester is associated with a significantly smaller infant.(22) Thus, the maternal weight gain pattern appears to relate to infant birth weight, and it is also likely that the pattern of maternal weight gain may relate to postpartum weight retention. Several epidemiological studies have attempted to quantify levels of maternal gestational weight gain that promote fetal weight while reducing excessive maternal weight retention after delivery. One study concluded that for women who gain excessively, there is a "point of diminishing returns in birthweight at the expense of increasing maternal obesity."(23) Another concluded that "excessive gestational weight gain before 20 weeks gestation was associated with increased postpartum weight retention, especially for well nourished, overweight women."(24) A third study concluded that, in women with normal pre-pregnancy weight, excessive gestational weight gain did not greatly enhance fetal growth but did increase the risk of postpartum overweight.(12) However, none of these studies were able to examine factors related to maternal weight gain during pregnancy or behavioral predictors of maternal postpartum weight.

Study objective and design

This project, "Postpartum Weight Changes: Implications for Military Women" is referred to in the rest of this report as the "ABC Study." It addresses the question "how long to allow for returning to weight and physical fitness that meet service standards" found on page 39 of the Institute of Medicine's 1995 report Recommendations for Research on the Health of Military Women. The same issue falls under Physical Standards Linked to Occupations, "The scientific basis for physical standards" on page I-6 of the September 15, 1995 Broad Agency Announcement for Defense Women's Health Research.

The major objectives of the study are to:

1) describe the pattern of weight loss during the first year after delivery in a large study group of active duty and military dependent women,
2) compare differences in weight loss by maternal characteristics, and
3) identify characteristics of women who are most likely to become permanently overweight or obese as a result of childbearing.

A detailed description of the study methodology is included in the 1998 Annual Project Report. The ABC Study was integrated into the Pediatrics Clinic at Balboa Hospital at the Naval Medical Center, San Diego (NMCSD). The study has two components: a series of cross-sectional slices at 3 days (0.1 month); 14 days (0.35 month); 2, 4, 6, 9 and 12 months; and a smaller longitudinal cohort. Some women in the study provide data at only one or two points of time (for example if enrolling at the end of the first postpartum year, or if entering or leaving the facility due to transfer, deployment, or separation). We intentionally selected the sequential design to accommodate routine military operations by which personnel are transferred, on

average, every 3 years. If we had utilized a strict prospective cohort design, we could automatically lose at least one-third of our cohort before completing follow-up. By defining our study groups according to infant age, data from women who are transferred can be utilized for the periods they participated, and new data from recent transfers can also be added to the study. In this report, we present results on the cross-sectional analyses as well as analyses of data from women who contributed data throughout the postpartum year.

Variables Studied

Data for this project were collected from 3 different sources: 1) Measurements of weight (and one height measurement) during clinic visits, 2) Clinic and Take-home Questionnaires, and 3) Medical Record Abstraction.

Weight and Height

Maternal postpartum weights were measured at each clinic visit on a calibrated, digital scale. The mother wore light clothing and no shoes. Each mother was weighed twice, and if the two weights disagreed by more than 0.1 kg, the mother was weighed a third time. Maternal height was measured at the first visit using a stadiometer. Height was measured at least twice to ensure accuracy. All enrollment measurements were collected by trained study staff, while the majority of the follow-up measurements were taken by clinic corpsmen who were formally trained to follow specific protocols. A quality assurance protocol was in place. A study staff member re-checked the accuracy of each person taking measurements on a routine basis and then provided retraining as needed. At the request of our collaborating pediatricians, we also recorded and entered infant weight, length and head circumference at each visit.

Questionnaires

We collected data using the following questionnaires:

- 3-7 Day Clinic Questionnaire: A short questionnaire consisting of ~8 questions given only to mothers enrolled at the 3 day weight check. We intentionally kept this instrument brief to minimize participant burden.

- 10-16 Day Clinic Questionnaire: A slightly longer questionnaire (~30 questions) given only to mothers at the 2-week well-baby check.

- 2-12 Month Clinic Questionnaire: This questionnaire was self-administered at each well-baby or non-urgent care appointment beginning at 2 months postpartum . Although it consists of ~ 50 questions, most women easily completed it in about 10-15 minutes.

- The Baseline Questionnaire: This questionnaire was intended to be administered at home at 2 months postpartum or whenever the mother enrolled if her baby is older than 2 months of age. It asked questions about family history, prenatal weight gain, smoking, physical activity, dieting practices and work during and after pregnancy and sociodemographic data.

Depression and body image scales covering the previous seven days were also included. This questionnaire was lengthy and relatively demanding in scope.

- The Follow-up Questionnaire: This questionnaire was intended to be administered at home at 12 months postpartum. It asks women to reflect upon the past year in relation to their work, physical activity, dieting behavior and infant feeding practices, etc. It also includes a depression scale for the previous seven days. This questionnaire was lengthy and relatively demanding in scope.

- The 12 Month Enrollment Questionnaire was designed specifically for women who enrolled at the 12-month visit. It replaces the Baseline and Follow-up Questionnaire by combining the most relevant questions from each. This questionnaire was also sent to women who enrolled earlier in the study, but never returned a baseline questionnaire. This questionnaire was lengthy and relatively demanding in scope. It was also administered at home.

- Mini Follow-up and Mini 12-Month Questionnaires were designed after we left the field to facilitate collection of final data from women who had not completed the study, either due to the age of their infants when we left the field or non-response. These questionnaires contained a subset of the most important questions from the full versions of the Follow-up and 12 Month questionnaires, however they required much less time to complete.

Questionnaire Content

As cited in the background section, many studies have examined postpartum weight loss, but most have limited their explanatory variables to a few factors, such as maternal age, parity, race, infant feeding method and prenatal weight gain. In most of the studies, even these few variables have been measured in rather crude ways, leaving many questions about the nature of the relationships analyzed. A few have measured physical activity or work in a cursory way. To our knowledge, the only study to collect data on weight history and dieting practices was in Swedish women. Except for this Swedish study, we are aware of no large studies that have simultaneously addressed a large array of factors that may influence postpartum weight. Thus, a major strength of the ABC Study is its comprehensive assessment of a wide range of social, prenatal, psychological, and lifestyle variables. The breadth and depth of the information we are collecting increases the potential that, unlike previous studies, when we find an association between a specific exposure and postpartum weight, we will be able to explain the relationship. Appendix B of the 1998 report contains a copy of the 2-12 month Clinic and Baseline Take-home questionnaires (other questionnaires are available upon request).

1) Depression: We measured depression using the Center for Epidemiologic Studies-Depression Scale (CES-D) because it was validated in the scientific literature (25) and it was used in other recent large studies of women (the National Institute of Aging's SWAN: Study of Women Across the Nation study, WIHS: Women's Interagency HIV Study, funded by several institutes within the National Institutes of Health, and the Centers for Disease Control's HERS: HIV Epidemiology Research Study). This instrument consists of 20 short questions that are easy to understand and are easily self-administered. We considered scales designed specifically to measure postpartum depression, particularly the Edinborough Postnatal Depression Scale (26),

but decided that the CES-D was a more useful assessment of mood for this population. We hypothesize that depression will be associated with excessive weight retention in some women and excessive weight loss in others.

2) Lactation: To measure intensity of lactation, we developed an infant feeding question for the clinic questionnaire. It was based upon the recommendations by the Institute of Medicine.(27) Our question differentiates between exclusive breast feeders, formula feeders and levels in between these extremes: partial and token breast feeders. Questions about other foods and juices fed to the baby were also included in the clinic questionnaire. To measure duration of breast-feeding, we also included questions in the 12 Month Follow-up questionnaire to determine when mothers began to wean their infants and stopped breast feeding completely. We also investigated the barriers to breast-feeding and the reasons women stopped. The series of possible responses compiled from other studies (28) served as the basis for this question.

3) Body Image: We conducted an extensive review of the literature addressing measurement of body image perceptions and identifying people with eating disorders. Because many of the questionnaires were outdated or extremely long and detailed, we chose to develop 4 very short questions about weight, shape, eating and appearance that generally measure the amount of time a mother thinks about these issues, using the same response categories in the CES-D (depression) scale.

We also chose to include a set of 9 silhouettes of women ranging from quite thin to very obese. These silhouettes have been validated in the literature (29) and have been used successful to measure body image of pregnant women.(30)

4) Dieting Practices: We compiled an extensive list of dieting practices based primarily upon questions utilized in the National Center for Health Statistics studies and other sources.(31,32)

5) Physical Activity: We worked very closely with our consultant exercise physiologist to develop a combination of validated scales to measure current overall activity and work-related activity.(33-38) These questions were then adapted to reflect recalled physical activity during pregnancy.

6) Active Duty Women: After meeting with active duty women (both postpartum mothers participating in our pre-tests and female pediatric staff), we developed a series of questions related to physical readiness test concerns and physical training requirements. These data should be useful in determining whether certain occupational practices, such as required PRT, are associated with more successful return to pre-pregnancy weight.

7) Social Support/Deployment/Spouses/Emotional Issues: We developed a series of questions to estimate social support because we did not identify a useful source of published questions after consulting with expert psychologists here at UCB. To our surprise, during the pretest, women universally stressed the importance of measuring spousal deployment as a potential factor in maternal postpartum weight. Therefore, we added questions to measure the duration of paternal deployment during the baby's first year. We also have included questions on

self-perceived stress and infant health problems as we suspect that in turn these factors may influence changes in maternal body weight.

8) Dietary Intake: The Health Habits and History Questionnaire (HHHQ-Block) is a semi-quantitative food frequency instrument developed and validated by Gladys Block at the National Cancer Institute and here at Berkeley. This self-administered questionnaire is highly respected and used in numerous studies throughout the United States to measure diet and health.(39) We included it to assess dietary intake during the 6-12 months postpartum period. However, this questionnaire was time consuming, and when we determined that the response rate to the Follow-up questionnaire was lower than expected, we removed the food frequency instrument. We intend to analyze the data for the more than 181 women who did complete it.

Medical Record Abstraction

The goal of medical record abstraction in the ABC Study was to collect information from the medical records of participants regarding their prenatal course and delivery. This information:

1) Provides demographic data,
2) Allows calculation of the gestational age of the infant at the time of delivery,
3) Allows calculation of the total weight gain and pattern of weight gain during pregnancy for the mother and
4) Provides information regarding the type of delivery, complications, and birth weight of the infant(s).

We are using these data to examine the relationship between prenatal, labor and delivery factors and the health and fitness of mothers in the first year following the delivery. Appendix C of the 1998 Annual Report contains a copy of the Medical Record Abstraction Form.

To obtain data from the prenatal records, we obtained informed consent to abstract medical records at Balboa Hospital, and other records from other hospitals, which were then abstracted onto our standard form by a trained staff.

The entire medical record abstraction process was managed by the MRA database at UCB, which tracked the progress of ordering, obtaining and successfully abstracting each record. The coded Medical Record data were then sent to our outside vendor for key entry. All copies of medical records are currently stored in locked cabinets to preserve confidentiality, and all will be destroyed at the end of data collection.

Study Implementation: Problems and Process

As described in previous reports, this project has been plagued with serious problems. Our subcontractor, Freeman Sullivan and Co, was originally responsible for setting up the study in San Diego, screening, enrolling and following study participants, collecting, verifying and keying measurement and questionnaire data, and tracking and reporting the success of these activities. Unfortunately, within a year, it became apparent that the contractor was unable to

successfully perform all these activities. Particularly, they were not tracking women's return visits to the clinic, obtaining mailed questionnaires (baseline and follow-up), and most importantly they were missing most of the women with 1-year-old infants. At one point, only 12% of all women with 1-year-old infants had completed and returned the Follow-up/exit questionnaire or had their weights measured at a year postpartum. This was a serious problem, as this measurement was the major outcome variable for the study. Furthermore, there were serious gaps in the follow-up data for individual women, compromising the longitudinal cohort data.

In addition, they fell behind in data entry, and billed at an unreasonably high rate for this portion of the work. Finally, 18 months into the data collection period, they threatened to shut down the study early due because they claimed they could not perform the promised work for the amount of money in the contract. At this point, to save the study, we renegotiated the contract, and brought to Berkeley most of the collection of mailed questionnaire data and some of the follow-up data collection. This involved hiring, training and supervising a team of graduate students to collect data by mail and phone and the development of "mini" versions of the Follow-up/exit and Combination Baseline-Follow-up questionnaires that could be mailed in large batches and easily completed by study participants. Doing this allowed us to collect data at end of the postpartum year for over 1000 participants that would have otherwise been lost due to the virtual breach of contract. However, it forced us to utilize self-reported versus measured weights, since the follow-up data collection occurred by mail rather than in person.

We also screened several new firms to perform the computer entry of the data, and settled on a highly recommended company, ODS, in Sacramento. This turned out to be a bad choice as ODS apparently experienced a managerial crisis shortly after undertaking our contract, and I believe that they ultimately went bankrupt shortly after delivering, several months late, our computerized data.

After several months of data analysis, we became suspicious that the data contained an unusual amount of variability and error. We therefore stopped the study analysis and devoted our attention to assessing the reliability of the dataset, by comparing the paper questionnaires with the computerized data. This process brought us to the conclusion that the data had not been double-keyed and verified as promised by the ODS. As a result, the University voided their contract and refused to pay them for this substandard work. We therefore had the resources to re-key the data using Richardson and Company who did an excellent job.

In addition, the University of California administration recently took responsibility for their inability to enforce the contract with Freeman Sullivan. Recognizing that we were forced to exhaust funds originally intended for data analysis budget in order to complete data collection at Berkeley, UC returned $165,000 from the study overhead to allow completion of data analysis.

Since receiving the more accurate data set, we have continued to reconcile, verify and clean the doubly entered data set. This has involved tedious examination of repeated measures. For example, the Principle Investigator recently examined every weight and time included in the data base for more than 500 individual women, to ensure that the data were valid and consistent.

This has increased our confidence in the data set, which was understandably shaken by the events described above.

As we expand analysis to include more and more variables, this detailed process of data cleaning continues. At this point, we are confident that the findings in this report are based on valid data. However, we will be re-analyzing all work from previous reports to confirm that those findings hold in our final cleaned data set.

Once data reconciliation was complete, we worked extensively on finalizing the study population based on study participation. Because the entry criteria for the study specified availability beyond the 10-16 day well baby visits, women who did not return to the clinic after the 10-16 day clinic visit were excluded (n=237). In addition, data were excluded for women who later dis-enrolled from the study (n=42), women who had no measured height and/or weight (n=50), and women who became pregnant during the study (n=154). After making these data-based exclusions, the final sample for this study is 2,433 women.

After finalizing the study population, we selected a final measure of pre-pregnancy weight, delivery weight, and postpartum weight at various time points for each study participant. Reports of pre-pregnancy weight were self-reported on the baseline questionnaire, the 12-month enrollment questionnaire, and the mini questionnaires collected by mail at the end of the data collection period. In addition, data on study participants' self-reported "usual weight" before pregnancy were obtained from medical records abstraction. Although all data on pre-pregnancy weight were obtained by subject self report, there was some within-participant variation. To select one value of pre-pregnancy weight for each woman, we identified the value closest to the first measured prenatal weight during the first trimester among those women who had MRA data. Among women who did not have MRA data, pre-pregnancy weight was taken from the baseline questionnaire when possible; if baseline data were not available, the data were taken from the mini questionnaires, which were reported at the end of the study. Data on pregnancy and postpartum weights were also cleaned; in a minority of records, impossible values that could not be reconciled were set to missing. The data have now been finalized, and analyses are proceeding according to the original proposal by the research team at UCB.

Progress on Technical Objectives

In the following section, we list each technical objective (shown in bold type) and describe our progress and relevant research results.

Task 1:

Hold advisory meeting. Finalize protocol, hire staff, field-test data collection methods. Begin recruiting women.

Except for the advisory meeting, these tasks are complete. We have chosen to delay a formal meeting with our Advisory Committee until we have sufficient data run on the final, cleaned dataset to share with them. However, we have contacted some members of the Advisory Committee for expert input and responses to our questionnaires/data collection procedures on an individual basis and will continue to do this. An advisory meeting is being planned for April

2002. This will give us sufficient time to re-examine our findings according to any recommendations received before the project funding ends.

Task 2:

a. **Collect data on 4000 women during the first year after birth. Recruit subjects, collect postpartum maternal weight measurements and questionnaires. Edit, code and enter data.** This task is complete.
b. **Obtain/abstract prenatal medical records, enter data.** This task is complete.
c. **Create a preliminary analytical data set by merging these data sources. Clean/edit data. Using this preliminary data set, begin programming data analyses for tasks 3-6.** Creation of the data set is accomplished.

Task 3:

Use parametric techniques to summarize the sequential measurements to provide estimates of the overall pattern of maternal weight gain during pregnancy and the pattern of maternal weight loss after birth.

As reported in the 2000-2001 report, we conducted longitudinal data analyses to describe the impact of various independent variables on postpartum weight change. These analyses are currently being repeated in the final, cleaned data set.

In this report, we utilize all measured weights from the maternal obstetrical records to summarize the pattern of prenatal weight gain as predictor of weight retention. Gestational weight gain pattern is summarized as 3 "piecewise" estimates of trimester gain. We are also investigating whether the use of regression techniques will yield more precise estimates of gestational gain or postpartum weight loss patterns (based on all measured maternal weights during well-baby visits) while allowing inclusion of a higher proportion of enrolled women, but have not yet reached a conclusion as to whether this approach substantially strengthens study results. The approach we are using can be described as follows: The weight measurements collected as part of the ABC study were made over the study period in no specific pattern. Some women measured more than 15 times and some fewer than three. These measurements occurred at any time during the study period. To take advantage of these longitudinal data, the observations must be organized in a fashion that allows the experience of each individual to be succinctly summarized and comparisons to be made between individuals.

Each set of weight gain/loss data was summarized by a non-linear curve. A curve was estimated to describe weight gained during pregnancy and a second curve was estimated to describe weight lost after delivery for each mother. Technically, the first curve was a cubic equation and the second curve was a quadratic equation. The cubic model was used to capture the more complicated pattern of weight gained and the quadratic model was sufficient to accurately summarize the weight lost. The two curves shared one point in common, the mother's weight at delivery.

Based on these curves, it is possible to select a series of comparable points. For example, the weights at each trimester of pregnancy were estimated and used to characterize weight gain. Similarly, the postpartum weights at 400 days and 500 days were similarly estimated by interpolation. That is, each mother is treated as if she was measure at exactly the same times (e.g., prepregnancy = 0 days, 90 days, 180 days, 270 days, 400 days and 500 days). For example, the data are statistically adjusted so that the ideal situation arises where all women delivered exactly after 280 days of gestation.

These six uniform and consistent measures are then used to characterize weight gained and lost during each mother's pregnancy (non-parametric regression techniques). Furthermore, these constructed variables can be combined to reflect such measures as total weight gained during pregnancy, total weight lost after pregnancy and weight retained from prepregnancy to 400 days postpartum. The interpolated values also serve as predictor variables in regression analysis which include other non-longitudinal variables (non-time dependent variables) such as mother's age, parity, rank and duty status. These analyses are free from the issues that arise from using a series of weight measurements taken at differing time throughout the study period. Using these estimated values may allow relatively straight-forward descriptions and analyses of the ABC data. If it does, we will report the findings in the final report.

Tasks 4-9:

Use multivariate statistical methods to:

A. Describe the postpartum weight loss pattern and prevalence of excessive weight retention at 2 weeks, 2,4,6,9 and 12 months after delivery, by military status, race and other maternal characteristics, comparing results using several definitions of postpartum weight retention.

We have replicated previous analyses of postpartum weight patterns on the cleaned data and present them here. We have also examined several different definitions of postpartum weight change, including weight loss from delivery to the end of the postpartum year, percent of prepregnancy weight retained and absolute postpartum weight, adjusted for time and prepregnancy weight. For this report, we show data for weight retention over prepregnancy weight, but our statistician is working out whether there are statistical issues that warrant use of an alternative definition, and if so, we will address this in our next report. We also compared measured versus self-reported prepregnancy weight as the anchor for postpartum weight retention. In general, the same risk factors are associated with various estimates of postpartum weight retention, so in this report, we present results on weight retention defined as any final postpartum weight before 551 days minus self-reported prepregnancy weight. We repeated this process examining measured versus self-reported postpartum weights as well, and found the data robust. Furthermore, we examined differences in findings by time of last postpartum weight measurement. When we compared the dataset including only women who provided a postpartum weight estimate late in the postpartum year (> 9 months) versus women who provided their last postpartum weight estimate at any time during the postpartum year adjusted for time, findings were remarkably similar. Therefore, for most analyses, weight retention is based on the last postpartum weight obtained for each woman, measured or self-reported and adjusted for time. This definition allows inclusion of largest number of enrolled participants, increasing generalizability and study power, and yielding results similar to the most restrictive approach.

B. Test the hypothesis that high maternal weight gain during pregnancy, especially during the first and third trimesters, will be associated with excessive maternal weight retention, after adjusting for potentially confounding variables including military status and risk factors.

Models examining trimester gestational weight gain are presented in this report.

C. Using bivariate and multivariate statistical models, examine how maternal circumstances (e.g. education, socioeconomic status, marital status, work, social support), and lifestyle behaviors during the postpartum period (including method of infant feeding, reported physical activity, dieting behavior, attitudes toward body size, work hours, sleep) relate to maternal change and excessive weight retention.

Last year we reported associations between increased maternal weight retention and maternal psychosocial stress, social support and depression. These models are currently being reanalyzed using the final cleaned data set, and a manuscript, based on the final, cleaned data set, will be submitted shortly.

In a previous report, we showed that women who retain weight are more likely to diet, and dieting was associated with increased, not decreased weight retention, suggesting a effect-cause relationship (i.e. those women with greater retention were more likely to diet). We addressed this problem by limiting the study group to women with weight left to lose, defining our exposure group of dieters versus non dieters at 2 months postpartum and then following weight change at 6 and 12 months. This analysis suggested that intentional dieting was associated with modest weight loss in all groups except African Americans. These results will be replicated on the final, cleaned data set and submitted for publication.

So far, a variety of analytical approaches have yielded no association between any of our measures of recreational physical activity and postpartum weight retention. This may be due to poor precision when the women self-report their activity. We plan to re-examine physical activity in several different ways, including specifically looking at activities reported by active duty women as part of physical readiness training, and looking at reported activity during pregnancy before concluding that there is no relationship.

Work on attitudes, employment status, and method of infant feeding have been partially addressed in the cross-sectional analyses and will be further addressed this year.

D. Use the results of previous analyses to attempt to identify those women who are most likely to become overweight as a result of childbearing, and to identify when postpartum (or during pregnancy) such women might be detected.

In this report, we show predictors of development of overweight/obesity among women to began their pregnancy within the "normal" BMI category. For this, we use the IOM cut-off of greater than 26 to be consistent with other analyses in the literature; we recognize that the military uses a BMI of 25 which is not substantially different.

Results

I. Description of the study population

Analyses were conducted to describe the final study population in terms of major covariates and the main outcome data.

The 2,433 women in the final study population are described in Table 1. The majority of the women were white (53%), though a sizable number of Asian, black, and Hispanic women were also followed (14%, 15%, and 16%, respectively). The mean age of the women in the data set was 25.7 years with a range of 15 – 45 years. Using the IOM guidelines to classify pre-pregnancy BMI, 11% of the women in the study had pre-pregnancy BMIs that were categorized

as underweight (BMI < 19.8), 60% were within the normal range (BMI; 19.8 – 26), 14% were categorized as overweight (BMI; 26-29), and 15 were categorized as obese (BMI > 29). Twenty-two percent of the women followed were active duty women, 78% were military dependants. The women in the study gained an average of 16.2 kg during pregnancy and retained an average of 3.9 kg by the end of the postpartum follow-up.

II. Cross Sectional Analysis

Bivariate descriptive analyses were conducted to describe the association between major covariates and weight retention at each cross section. Study participants may have contributed to any one or all of these cross sections. Care must be taken in the interpretation of these analyses; because each cross section describes a different population, differences in a variable at two time-points may merely represent differences in the populations being measured.

As shown in the table below, at least 800 women contributed data at each of the six study visits. The study visits took place at a mean of 9, 63, 127, 189, 278, and 379 days, respectively.

Days Since Birth:
Cross-sections of Clinic Questionnaires Completed by Study Participants

Visit	Days	N	Mean	(SD)
1	0-20	1000	9	(5)
2	21-105	1357	63	(12)
4	106-166	1292	127	(11)
6	167-227	1191	189	(12)
9	228-319	918	278	(17)
12	320-881	840	379	(37)

The mean weight retention at each study visit is shown in the table below. As expected, the mean weight retention decreases at each study visit. Despite this, the mean retention at 12 months is quite large (3.33 kg). Most previous studies have shown weight retention at about half this magnitude.

At each study visit, there is large variation in weight retention around the mean, with some women reporting large amounts of weight loss and others reporting a very large retention. Because of the cross sectional nature of this analysis, it is unknown whether these large retentions represent weight never lost postpartum or if the pregnancy weight was lost only to be regained later postpartum. This issue is being addressed in the longitudinal analyses to be reported in the Final Report.

Days Since Birth and Retention:
Cross-sections of Clinic Questionnaires Completed by Study Participants

					Retention (kg)
Visit	Equivalent time	N	Mean	(SD)	Range
1	≤ 20 days	954	7.5	(6.4)	-13.7, 38.5
2	21 days–2 months	1265	5.6	(5.8)	-17.8, 35.8
4	4 months	1202	5.1	(6.0)	-29.2, 33.6
6	6 months	1099	4.9	(6.3)	-25.8, 33.9
9	9 months	823	4.2	(6.1)	-18.6, 34.2
12	12 months	733	3.3	(6.5)	-36.6, 34.2

We have also conducted bivariate analyses to examine the relationship between weight retention and a number of covariates (*Tables 2-7*). Selected results are described below.

At visit 1, being on active duty (versus military dependants) was associated with a significantly higher weight retention ($p=0.01$). Active duty status was also associated with a significantly higher weight retention at visit 2 ($p=0.003$) and a non-significantly higher retention at visit 4. At visits 6, 9, and 12, active duty women retained less weight than military dependants, and this difference was significant at visit 12 ($p=0.02$).

A history of weight cycling (reporting having lost 10 pounds three or more times, excluding pregnancy) was consistently associated with higher weight retention at each of the cross sections. The association between these variables was statistically significant ($p<=0.01$) at each visit except visit 12, when the association had a borderline significance ($p=0.07$). At each cross section, a history of weight cycling was associated with at least a one-kilogram additional weight retention.

At visits 1, 2, 4, and 6, weight retention varied significantly according to pre-pregnancy BMI category ($p<=0.01$). At each cross section, the group of women who were obese prior to pregnancy retained the least weight.

At visit 2, women who were breast feeding exclusively or in combination with formula feeding were retaining less weight than women who were exclusively formula feeding their infants ($p=0.03$); this statistically significant finding held at each of the other cross sections except visit 12.

III. Multivariate Models

<u>Outcome 1:</u> Postpartum Weight Retention

A. Trimester Weight Gain

One major covariate of interest in exploring postpartum weight retention is the amount of weight gained during pregnancy. In order to explore this relationship in depth, we conducted multivariate linear regression on weight retention. The relationship between pregnancy weight gain and weight retention was examined by including terms in the model for the amount of weight gained during each of the three trimesters of pregnancy. Weight retention was generated by subtracting the study participant's self-reported pre-pregnancy weight from her final recorded postpartum weight (measured or self reported), which was at or before 551 days postpartum. The model is shown stratified on pre-pregnancy BMI category (underweight and normal weight, overweight and obese) as interactions were found between pre-pregnancy BMI and other covariates.

Table 8 displays the average weight retentions of the 1051 women in the model stratified by pre-pregnancy BMI category (≤ 26 versus > 26). The average weight retention is 3.2 kg in both groups examined. There were significant bivariate associations between weight retention and race, income, history of weight cycling, pre-pregnancy BMI, first, second, and third trimester weight gain, and maternal age in the underweight/normal weight group. In the overweight/obese group, there were significant bivariate associations between weight retention and race, history of weight cycling, and first, second, and third trimester weight gain.

The multivariate models are presented in *Table 9*. In the underweight/normal weight women, the amount of weight gained in each trimester of pregnancy was significantly associated with postpartum weight retention. The greatest impact was seen in the association between first trimester weight gain and postpartum weight retention with almost 50% of first trimester gain retained postpartum. In contrast, approximately one third of 2nd or 3rd trimester gain was retained postpartum. Results from the model examining weight retention among the overweight/obese women were even stronger. Again, first trimester weight gain had the strongest association; in this group 80% of first trimester gain was retained postpartum; about a third of second trimester gain and almost half of third trimester gain was retained postpartum. In neither group was active duty status significantly associated with postpartum weight retention. (*Tables 10 and 11* show the models stratified by active duty status.)

This model suggests that more of the weight retained postpartum is that gained in the first trimester of pregnancy. This finding is reasonable given that weight gained in the second and third trimesters must contribute to the rapid growth of the fetus as well as the placenta, while fetal weight increases only slightly in absolute terms during the first trimester. Given replication, this finding has direct clinical applications in that women could be cautioned to avoid large amounts of weight gain during their first trimester of pregnancy.

B. History of Weight Cycling

About a third of the women in the study reporting losing 10 lbs or more at least 3 times in their lives, our definition of weight cycling. We examined the impact of a history of weight cycling on postpartum weight retention. *Table 12* presents the multivariate models examining weight cycling; due to interactions, the models are presented stratified by race. A history of

weight cycling appears to be associated with increased postpartum weight retention in all race groups but Hispanics, though it is only statistically significant among white women. In white, black, and Asian women, a history of weight cycling is associated with over a one kilogram weight retention, even after adjusting for socio-demographic factors and the amount of pregnancy weight gain.

In order to examine whether the influence of weight cycling also was varied by pre-pregnancy BMI, we ran the same models in the white women separately by pre-pregnancy BMI category (under/normal weight; overweight/obese) (*Table 12*). This is the only race-ethnic group with enough women to stratify by body size. A history of weight cycling was found to be more strongly associated with postpartum weight retention among underweight/normal weight women than among overweight /obese women. Among under/normal weight women, a history of weight cycling is significantly associated with a 1.86 kg weight retention. Among overweight and obese women, a history of weight cycling is non-statistically significantly associated though there is still an increased weight retention (1.22 kg).

This set of analyses indicates that a history of weight cycling is a potential risk factor for increased postpartum weight retention, although it is unknown whether the history of weight cycling causes increased gain and retention or whether it is a marker for genetic, behavioral or other characteristics associated with difficulty in controlling weight gain. The extent to which a history of weight cycling contributes to postpartum weight retention varies somewhat by race, and among whites, is associated with higher weight retention among under and normal weight (BMI $\leq$ 26) compared to overweight/obese women (BMI >26). These interactions by race-ethnicity and body size affect the estimates of associations for weight cyclers for our various models. For example, *Tables 9 and 11* show weak estimates for the association between cycling history and retention because they adjust for race but do not address the race-cycling interaction, due to limited sample size.

Nonetheless, these findings are interesting in light of other research that has shown that a history of weight cycling is associated with lower levels of "good" cholesterol, increasing these women's risk of death from heart disease (25). However, the effects of weight cycling on health outcomes have been controversial. To our knowledge, this is the first study to examine how weight cycling relates to weight change during and after reproduction. This finding could provide clinicians with information about a factor for which to screen to identify women most likely to gain and retain excessive pregnancy weight.

C. Obesity Development at or after 6 months postpartum

For this analysis, we limited the study group to women with a normal pre-pregnancy BMI (19-26) so that we could examine determinants of postpartum overweight/obesity development (BMI >26; we chose this cut-off to be consistent with IOM pre-pregnancy BMI categories. It is quite close to the IOM's Military Women's health report cut-ff of 25). As no underweight women became obese, we excluded them from this analysis. *Table 14* compares characteristics of women with and without postpartum obesity. Twenty-one percent of these women with normal pre-pregnancy weight became overweight or obese. *Table 15* suggests that after adjustment using multiple logistic regression techniques, prenatal weight gain during each of the

three trimesters and history of weight cycling were associated significantly with increased odds of becoming obese postpartum. *Tables 16 and 17* directly address active duty status. Twenty-three percent of active duty women in this analysis became overweight, and the same risk factors held as for the entire study group.

Outcome 2: Pregnancy Weight Gain

Rationale: High or excessive gestational weight gain emerged as the most important predictor of postpartum weight retention. Therefore, the following section attempts to identify risk factors that hold the potential for moderating prenatal weight gain. Further work is ongoing in this area.

In order to explore the variables associated with the amount of weight gained during pregnancy, we ran a multivariate model that included factors previously found to be associated with pregnancy weight gain as well as factors we wished to explore (*Table 18*). Gestational weight gain was calculated by subtracting a woman's self-reported pre-pregnancy weight from her last measured prenatal weight. Among women whose pregnancy data were not abstracted from the medical records, gestational weight gain was self-reported.

We stratified the models on race due to interactions with this variable. In all race groups, pre-pregnancy weight was significantly negatively associated with gestational weight gain and maternal height was significantly positively associated with the amount of pregnancy weight gain. A history of weight cycling was also associated with a greater gestational weight gain in all race groups; the association was statistically significant in the White, Black, and Asian groups. Being on active duty was significantly positively associated with gestational gain in the White and Hispanic women; the association between active duty status and gestational gain was not significant in the Black and Asian groups, but the association was positive in the Black group and negative in the Asian group. Finally, the duration of the pregnancy (gestational age) was positively associated with gestational gain in all four race groups, and the association was significant in all but the Black group.

We wished to explore the associations between these variables and gestational gain separately in women with a pre-pregnancy BMI <=26 (normal and underweight women) and those with a pre-pregnancy BMI > 26. Because of relatively small numbers in the Black, Asian, and Hispanic groups, we conducted these stratified models in white women (*Table 19*). In women with a pre-pregnancy BMI <=26, maternal age was significantly negatively associated with gestational weight gain, and gestational age and a history of weight cycling were significantly positively associated with gestational gain.

Among overweight and obese women, pre-pregnancy weight was significantly negatively associated with gestational gain, while maternal height and active duty status were significantly positively associated with gestational gain.

This set of models indicates that a history of weight cycling has a fairly consistent association with higher gestational weight gains; the magnitude of this association is quite large as a history of weight cycling is associated with up to a 2.89 kg increase in gestational weight

gain. There was also an interesting association between gestational weight gain and active duty status. Where this association was significant, being on active duty was associated with an increase in gestational weight gain of over 1 kg in the white and black women, and over 2 kg in the Hispanic women. In the models including only white women stratified by pre-pregnancy BMI, active duty status was associated with over a 3 kg increase in gestational gain in women with a pre-pregnancy BMI > 26.

Summary of Key New Findings:

Higher levels of trimester prenatal weight gain were associated with higher adjusted postpartum weight retention. In particular weight gain during the first trimester is most likely to be retained. This finding holds regardless of prepregnancy BMI.

A history of weight cycling is associated with higher gestational weight gain in all race groups except Hispanic women.

Except in Hispanic women, a history of weight cycling is associated with higher postpartum weight retention and increased risk of becoming overweight in women who started pregnancy at normal weight.

Future Directions

In these last months of funding, we have established a team of nine investigators to conduct and complete project analysis. Following are summaries of some of the work currently being conducted.

Psychosocial, Demographic, and Nutritional Predictors of Postpartum Depression

Postpartum depression is a significant health concern to both mothers and their babies, with numerous studies finding an association between postpartum depression and negative maternal and child outcomes such as decreased social functioning of the mother and decreased social and cognitive functioning in the infant. Although other researchers have identified several risk factors for postpartum depression, few have looked at the influence of weight, body image and maternal stress on postpartum depression. In addition, no studies to date have looked at the association of weight cycling history to postpartum depression. The purpose of this project is to explore new areas of research in the field of postpartum depression by looking at the associations between postpartum depression and weight, body image and/or stress, while also examining the relationship of postpartum depression and a history of weight cycling. This project will describe how results differ from previous findings (as available), and determine if postpartum weight retention, body image, stress, and a history of weight cycling contribute to the model of various risk factors surrounding postpartum depression. We will also examine active duty women and their non-active duty counterparts separately to determine if there are different rates and covariates of postpartum depression in these two populations.

Predictors of Initiation and Duration of Breastfeeding

Although many professional organizations agree that breastfeeding provides the optimum nutrition for a human infant, rates of breastfeeding initiation and length of breastfeeding duration continue to be far below Healthy People objectives. Findings indicate that the variables that are associated with breastfeeding initiation and longer duration are correlated with social status, ethnicity, and cultural factors. Education and provider knowledge are also predictive of breastfeeding status.

Future directions for research on the ABC population include analysis to examine the predictors of initiation of breastfeeding and extended breastfeeding (more than a six month duration of lactation). We will describe how results differ from previous findings.

Determinants of Gestational Weight Gain Within Current IOM Recommendations

In the past 50 years, there have been substantial changes in the medical community's opinion of appropriate weight gain during pregnancy. In 1950, the accepted standard of medical practice was to gain no more than 20 pounds during pregnancy. In 1970, the recommendation increased to a recommended range of 20-25 pounds to ensure optimal fetal growth and health. After 1974, the recommendation changed again to reflect the most updated research; a weight gain of 22-27 pounds was recommended during the course of a normal pregnancy (26).

Most recently, the IOM has changed the recommendation to reflect guidelines for gestational weight gain based on women's pre-pregnancy BMI. Since 1990, several studies have validated the soundness of the recommendation for decreasing the risk of low as well as high birth weight (27). Other favorable outcomes include a reduction in maternal complications, cesarean deliveries and pre-term deliveries, and postpartum weight changes (28). The latter outcome is critical at this time when obesity is occurring in epidemic proportions. The strongest factor contributing to postpartum weight changes is, in fact, gestational weight gain (29). Hence, the current gestational weight gain recommendation may provide some protection against postpartum obesity.

Unfortunately, only 30-40% of all women presently gain weight within the current recommendations. Little research has been conducted to determine the factors that influence women to gain within these guidelines. The present dataset will be analyzed to answer a number of questions pertaining to the determinants of gestational weight gain within the recommended weight ranges. This research will allow practitioners to identify women at risk of gaining weight outside of the IOM recommended ranges and ultimately prevent associated risks of poor maternal and birth outcomes. Additionally, it will allow practitioners to devise more effective weight management interventions.

The Relationship Between Gestational Weight Gain and Maternal and Infant Health Outcomes

Research examining the Institute of Medicine (IOM) recommendations on gestational weight gain and its relationship with maternal and infant health outcomes has been inconsistent. Some studies show that gestational weight gain within IOM recommendations are associated

with increased chance of healthy birth weight, decreased risk of cesarean section, and decreased risk of postpartum weight retention; other studies do not show these results. One reason for these discrepant findings is the wide variety of study designs that have been employed to investigate the relationship. Some studies have examined only one of these outcomes, and others have studied pairs of these outcomes. The purpose of this project is to replicate a recent study of gestational weight gain and maternal and infant outcomes; to include birth weight, cesarean section, *and* postpartum weight retention as outcome variables; to describe how results differ from previous findings; and to add to the model being replicated to determine if additional variables improve the description of the relationship.

In addition to the analyses described above, analyses are ongoing to explore patterns of gestational weight gain and postpartum weight loss, to examine the impact of lactation on postpartum weight retention, and to revisit maternal physical activity (Both in active-duty and dependents) as a moderator of postpartum weight.

Key Research Accomplishments for this period

- We have completed recruitment, data collection and data entry for the study group of new mothers attending the well-baby clinic at the Naval Medical Center, San Diego. We enrolled more than 2500 eligible women and obtained essential data from 2433 of them.
- Women in this study, on average, retained more weight late in the postpartum year than reported by other investigators.
- Major risk factors for high postpartum weight retention include excessive prenatal weight gain (particularly during the first trimester) and history of weight cycling.
- History of weight cycling is also a risk factor for excessive prenatal weight gain, and may be a good marker for women who are likely to retain too much weight postpartum.

Reportable Outcomes

Manuscripts, abstracts, presentations:

· Barbara Abrams, DrPH, Katherine Hoggatt, MPH, Mi-Suk Kang, MPH, Steve Selvin, PhD, Weight Cycling, Ethnicity and Postpartum Weight Retention: The ABC Study 2001

· Barbara Abrams, DrPH, Katherine Hoggatt, MPH, Mi-Suk Kang, MPH, Steve Selvin, PhD Is History of Weight Cycling Related to Weight Changes During and After pregnancy? The ABC Study 2001

· Concurrent session on pregnancy, weight gain and postpartum weight retention. National Summit on Safe Motherhood, US Centers for Disease Control, Atlanta, September, 2002.

Degrees obtained:

Serena Wright, MPH

Tabitha Notolny, MPH

Conclusion of this Annual Report

See key accomplishments above.

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Appendix A

Table 1. Description of ABC Study Population

Characteristics	N	% or mean ± sd
Age (years) (mean sd)	2420	27.7 ± 5.4
Parity (mean sd)	2245	0.8 ± 0.9
Race		
White	1250	53
Black	349	15
Asian	319	14
Hispanic	368	16
Other	53	2
Active Duty Status		
Active Duty	541	22
Military Dependant	1892	78
Education completed		
< HS grad	108	5
HS grad/trade school	777	39
Some college	1097	55
Income (per month)		
< $1501	446	23
$1501-$3000	1055	54
$3000+	450	23
Pre-pregnancy BMI		
Underweight (<19.8)	256	11
Normal weight (19.8-26)	1347	60
Overweight (26-29)	308	14
Obese (>29)	343	15
Gestational age (weeks) (mean sd)	1999	38.9 ± 1.5
Gestational weight gain (mean ± sd)	2278	16.3 ± 6.7
Trimester 1 (mean ± sd)	1450	2.4 ± 3.3
Trimester 2 (mean ± sd)	1451	6.1 ± 3.3
Trimester 3 (mean ± sd)	1704	7.7 ± 3.7
Time of final postpartum measurement (mean ± sd)	2430	315 ± 126
Final Postpartum BMI		
Underweight (<19.8)	185	7.6
Normal weight (19.8-26)	1201	49.4
Overweight (26-29)	463	19.1
Obese (>29)	581	23.9
Weight retention at final postpartum visit (mean, sd)	2254	3.9 ± 6.8

CROSS-SECTIONAL ANALYSES

Table 2. Maternal Characteristics and Weight Retention by Clinic Visit: ≤ 20 Days
N=1000

Characteristic	N	%	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)					0.44	0.64
< $1501	170	21	7.5	(6.8)		
$1501-$3000	449	55	7.3	(6.4)		
$3000 +	205	25	7.8	(5.6)		
Education					0.34	0.71
< HS grad	38	5	7.6	(5.2)		
HS grad/trade school	326	39	7.2	(6.5)		
Some college	471	56	7.6	(6.2)		
Active duty status					7.27	0.01
Not active duty	729	76	7.1	(6.3)		
Active duty	225	24	8.5	(6.7)		
Race					0.42	0.79
White	515	54	7.4	(6.3)		
Black	133	14	7.4	(7.0)		
Asian	133	14	8.0	(5.8)		
Hispanic	152	16	7.3	(6.7)		
Other	21	2	6.3	(6.5)		
Exercise (# of times/week)					1.84	0.14
0	409	71	6.2	(5.9)		
1-2	67	12	5.6	(5.8)		
3-4	62	11	5.8	(6.2)		
5+	41	7	8.3	(8.0)		
Breastfeeding behavior					2.49	0.08
Breast milk only	471	50	7.4	(6.1)		
Formula milk only	167	18	6.7	(6.9)		
Mixed breast and formula milk	308	33	8.1	(6.5)		
Pre-pregnancy BMI					25.23	<0.001
Underweight (<19.8)	92	10	9.6	(6.1)		
Normal weight (19.8-26)	575	60	8.1	(5.5)		
Overweight (26-29)	120	13	7.9	(7.6)		
Obese (>29)	167	18	3.8	(7.4)		
Age (years)					1.28	0.28
< 20	64	7	8.5	(7.2)		
20-34	813	86	7.3	(6.4)		
35+	74	8	8.0	(6.4)		
Financial Insecurity					2.31	0.10
Yes	803	86	7.3	(6.4)		
No	55	6	8.4	(6.8)		
Unsure	73	8	8.8	(6.3)		
Depressed for > half the time					0.30	0.59
No	38	93	6.7	(5.0)		
Yes	3	7	8.3	(3.3)		
Weight cycler status					7.01	0.01
Has not lost 10 lbs ≥ 3 times	517	70	7.1	(5.9)		
Has lost 10 lbs ≥ 3 times	218	30	8.5	(7.5)		

Table 3. Maternal Characteristics and Weight Retention by Clinic Visit; 20 days – 2 months

N=1357

Characteristic	N	%	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)					0.56	0.57
< $1501	248	23	5.9	(6.5)		
$1501-$3000	587	54	5.5	(5.8)		
$3000 +	261	24	5.5	(4.9)		
Education					1.02	0.36
< HS grad	60	5	6.6	(7.7)		
HS grad/trade school	435	39	5.6	(6.3)		
Some college	619	56	5.5	(5.1)		
Active duty status					8.66	0.003
Not active duty	967	76	5.4	(5.8)		
Active duty	298	24	6.5	(5.7)		
Race					1.40	0.23
White	675	53	5.9	(5.7)		
Black	189	15	5.7	(6.2)		
Asian	165	13	5.2	(5.2)		
Hispanic	205	16	5.1	(6.0)		
Other	30	2	4.4	(5.9)		
Exercise (# of times/week)					0.39	0.76
0	526	43	5.7	(5.6)		
1-2	256	21	6.0	(5.9)		
3-4	278	23	5.5	(5.9)		
5+	167	14	5.5	(6.0)		
Breastfeeding behavior					3.49	0.03
Breast milk only	382	31	5.3	(5.8)		
Formula milk only	531	43	6.2	(6.0)		
Mixed breast and formula milk	326	26	5.3	(5.3)		
Pre-pregnancy BMI					17.82	<0.001
Underweight (<19.8)	120	10	7.0	(5.1)		
Normal weight (19.8-26)	769	61	6.0	(5.1)		
Overweight (26-29)	168	13	6.2	(6.0)		
Obese (>29)	208	16	3.1	(7.4)		
Age (years)					1.55	0.21
< 20	97	8	6.5	(7.0)		
20-34	1058	84	5.5	(5.7)		
35+	106	8	6.1	(5.1)		
Financial Insecurity					3.11	0.04
Yes	933	78	5.5	(5.5)		
No	144	12	6.8	(6.9)		
Unsure	117	10	5.7	(6.3)		
Depressed for > half the time					1.52	0.22
No	1122	92	5.6	(5.8)		
Yes	92	8	6.4	(5.8)		
Weight cycler status					7.16	0.01
Has not lost 10 lbs ≥ 3 times	702	69	5.3	(5.3)		
Has lost 10 lbs ≥ 3 times	311	31	6.4	(6.7)		

Table 4. Maternal Characteristics and Weight Retention by Clinic Visit; 4 months

N=1292

Characteristic		N	(%)	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)						4.56	0.01
	< $1501	224	21	5.9	(7.4)		
	$1501-$3000	571	53	5.1	(5.97)		
	$3000 +	273	26	4.3	(4.6)		
Education						0.27	0.76
	< HS grad	51	5	5.1	(6.95)		
	HS grad/trade school	387	36	5.3	(6.5)		
	Some college	648	60	5.0	(5.67)		
Active duty status						1.35	0.24
	Not active duty	941	78	5.0	(6.19)		
	Active duty	261	22	5.5	(5.6)		
Race						1.36	0.24
	White	669	56	5.3	(5.9)		
	Black	169	14	5.5	(6.2)		
	Asian	164	14	4.2	(5.9)		
	Hispanic	176	15	5.1	(6.2)		
	Other	23	2	4.4	(6.3)		
Exercise (# of times/week)						1.08	0.36
	0	433	37	4.9	(6.2)		
	1-2	266	23	5.0	(5.6)		
	3-4	290	25	5.2	(6.0)		
	5+	167	14	5.9	(6.2)		
Breastfeeding behavior						7.34	0.001
	Breast milk only	284	24	4.1	(5.5)		
	Formula milk only	652	55	5.7	(6.3)		
	Mixed breast and formula milk	246	21	4.8	(5.6)		
Pre-pregnancy BMI						9.51	<0.001
	Underweight (<19.8)	126	10	5.0	(4.8)		
	Normal weight (19.8-26)	725	60	5.0	(5.2)		
	Overweight (26-29)	168	14	7.2	(6.7)		
	Obese (>29)	183	15	3.9	(8.1)		
Age (years)						1.35	0.26
	< 20	82	7	5.9	(6.4)		
	20-34	1012	84	5.0	(5.9)		
	35+	104	9	5.7	(5.9)		
Financial Insecurity						4.06	0.02
	Yes	910	79	4.9	(5.6)		
	No	129	11	6.3	(8.3)		
	Unsure	109	9	5.8	(6.1)		
Depressed for > half the time						1.11	0.29
	No	1083	93	5.1	(5.8)		
	Yes	87	7	5.8	(8.4)		
Weight cycler status						16.28	<0.001
	Has not lost 10 lbs ≥ 3 times	691	69	4.6	(5.5)		
	Has lost 10 lbs ≥ 3 times	309	31	6.3	(6.9)		

Table 5. Maternal Characteristics and Weight Retention by Clinic Visit; 6 months
N=1191

Characteristic	N	(%)	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)					6.78	0.001
< $1501	217	22	5.6	(7.6)		
$1501-$3000	530	53	4.9	(6.4)		
$3000 +	258	26	3.6	(4.5)		
Education					3.96	0.02
< HS grad	37	4	6.4	(9.0)		
HS grad/trade school	403	40	5.3	(6.9)		
Some college	580	57	4.3	(5.6)		
Active duty status					0.22	0.64
Not active duty	880	80	4.9	(6.4)		
Active duty	219	20	4.7	(5.9)		
Race					2.82	0.02
White	616	56	5.0	(6.5)		
Black	143	13	5.8	(6.4)		
Asian	132	12	3.4	(5.3)		
Hispanic	180	16	4.8	(5.9)		
Other	27	3	4.0	(8.0)		
Exercise (# of times/week)					1.36	0.25
0	410	39	4.4	(6.5)		
1-2	215	20	4.9	(5.5)		
3-4	274	26	5.2	(6.7)		
5+	156	15	5.3	(6.4)		
Breastfeeding behavior					8.68	<0.001
Breast milk only	211	20	3.6	(5.2)		
Formula milk only	680	64	5.4	(6.7)		
Mixed breast and formula milk	178	17	3.9	(5.6)		
Pre-pregnancy BMI					4.10	0.01
Underweight (<19.8)	133	12	4.0	(4.8)		
Normal weight (19.8-26)	670	61	4.7	(5.7)		
Overweight (26-29)	145	13	6.5	(7.8)		
Obese (>29)	151	14	4.6	(8.2)		
Age (years)					7.11	0.001
< 20	87	8	7.3	(7.8)		
20-34	914	84	4.6	(6.2)		
35+	93	9	4.7	(5.6)		
Financial Insecurity					0.67	0.51
Yes	852	81	4.8	(6.3)		
No	120	11	5.4	(6.4)		
Unsure	81	8	5.1	(7.0)		
Depressed for > half the time					1.94	0.16
No	979	92	4.7	(6.3)		
Yes	84	8	5.7	(6.9)		
Weight cycler status					22.01	<0.001
Has not lost 10 lbs ≥ 3 times	677	71	4.1	(5.8)		
Has lost 10 lbs ≥ 3 times	276	29	6.3	(7.3)		

Table 6. Maternal Characteristics and Weight Retention by Clinic Visit; 9 months

N=918

Characteristic	N	(%)	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)					6.9	0.001
< $1501	155	21	4.6	(6.9)		
$1501-$3000	392	52	4.7	(6.1		
$3000 +	204	27	2.9	(4.6)		
Education					4.58	0.01
< HS grad	34	4	6.9	(8.7)		
HS grad/trade school	288	38	4.5	(6.5)		
Some college	442	58	3.8	(5.3)		
Active duty status					2.69	0.10
Not active duty	650	79	4.3	(6.0)		
Active duty	173	21	3.5	(6.1)		
Race					0.62	0.65
White	470	57	4.1	(6.1)		
Black	109	13	3.7	(6.1)		
Asian	97	12	4.0	(5.7)		
Hispanic	127	15	4.9	(5.9)		
Other	19	2	4.2	(7.3)		
Exercise (# of times/week)					1.85	0.14
0	287	37	3.7	(5.5)		
1-2	159	21	4.1	(6.1)		
3-4	193	25	3.8	(5.9)		
5+	131	17	5.1	(7.0)		
Breastfeeding behavior					4.50	0.02
Breast milk only	127	16	3.0	(5.7)		
Formula milk only	561	71	4.5	(6.1)		
Mixed breast and formula milk	99	13	3.2	(5.5)		
Pre-pregnancy BMI[2]					1.95	0.12
Underweight (<19.8)	99	12	3.7	(4.7)		
Normal weight (19.8-26)	507	62	4.1	(5.8)		
Overweight (26-29)	107	13	5.4	(6.7)		
Obese (>29)	110	13	3.6	(7.3)		
Age (years)					4.12	0.02
< 20	64	8	6.2	(7.7)		
20-34	683	83	4.0	(6.0)		
35+	72	9	3.8	(4.9)		
Financial Insecurity					3.59	0.03
Yes	640	83	3.8	(5.7)		
No	81	11	5.0	(7.7)		
Unsure	50	6	5.8	(6.4)		
Depressed for > half the time					2.71	0.10
No	733	94	4.0	(5.8)		
Yes	48	6	5.4	(7.7)		
Weight cycler status					8.30	0.004
Has not lost 10 lbs ≥ 3 times	494	70	3.7	(5.6)		
Has lost 10 lbs ≥ 3 times	214	30	5.1	(6.5)		

Table 7. Maternal Characteristics and Weight Retention by Clinic Visit; 12 months+

N=840

Characteristic	N	(%)	Mean Weight Retention (kg)	(SD)	F	p-value
Income (per month)					2.89	0.06
< $1501	155	23	3.6	(6.9)		
$1501-$3000	350	53	3.6	(6.8)		
$3000 +	161	24	2.2	(4.4)		
Education					5.01	0.01
< HS grad	36	5	5.6	(9.4)		
HS grad/trade school	248	37	3.8	(6.7)		
Some college	389	58	2.7	(5.7)		
Active duty status					5.09	0.02
Not active duty	584	80	3.5	(6.6)		
Active duty	149	20	2.2	(6.0)		
Race					3.16	0.01
White	399	55	3.0	(6.4)		
Black	101	14	3.8	(7.9)		
Asian	101	14	2.2	(4.9)		
Hispanic	109	15	4.9	(5.5)		
Other	22	3	1.8	(10.6)		
Exercise (# of times/week)					1.42	0.23
0	260	40	2.7	(6.5)		
1-2	133	20	4.1	(7.4)		
3-4	179	27	3.4	(6.2)		
5+	95	14	3.7	(6.2)		
Breastfeeding behavior					1.49	0.23
Breast milk only	47	7	2.4	(5.7)		
Formula milk only	520	79	3.5	(6.7)		
Mixed breast and formula milk	88	13	2.5	(6.3)		
Pre-pregnancy BMI					0.92	0.43
Underweight (<19.8)	80	11	2.7	(4.7)		
Normal weight (19.8-26)	459	63	3.1	(5.8)		
Overweight (26-29)	97	13	4.2	(7.2)		
Obese (>29)	97	13	3.4	(9.4)		
Age (years)					3.16	0.04
< 20	60	8	5.3	(8.5)		
20-34	605	83	3.1	(6.4)		
35+	65	9	3.1	(5.1)		
Financial Insecurity					4.61	0.01
Yes	535	81	3.0	(6.4)		
No	79	12	4.2	(6.4)		
Unsure	48	7	5.7	(7.2)		
Depressed for > half the time					0.20	0.66
No	617	92	3.4	(6.4)		
Yes	55	8	3.0	(9.0)		
Weight cycler status					3.35	0.07
Has not lost 10 lbs ≥ 3 times	409	70	2.8	(5.3)		
Has lost 10 lbs ≥ 3 times	173	30	3.8	(7.4)		

MULTIVARIATE RESULTS:

- **Sample Descriptions**
- **Model Results**
  - **By Pre-Pregnancy Body Size (all races)**
  - **By Active Duty Status (all races)**
  - **By Race (all body sizes)**
  - **By Pre-Pregnancy Body Size (in white women)**

Table 8. Association between covariates and weight retention by Pre-Pregnancy Body Size

	Underweight/Normal Weight n = 734				Overweight/Obese n = 317			
	N	Mean ± SD (kg)	F	p value	N	Mean ± SD (kg)	F	p value
Average Weight Retention	734	3.2 ± 5.3			317	3.2 ± 8.3		
Race								
White	418	2.8 ± 5.4	3.41	0.02	180	4.2 ± 8.1	3.02	0.03
Black	94	4.2 ± 5.6			51	2.0 ± 8.3		
Asian	114	2.8 ± 4.0			27	-0.3 ± 6.6		
Hispanic	108	4.1 ± 5.5			59	2.5 ± 8.9		
Monthly Income								
<$1501	131	3.3 ± 5.6	6.27	0.002	70	3.3 ± 9.7	0.05	0.95
$1501-3000	386	3.7 ± 5.5			191	3.0 ± 8.1		
> $3000	217	2.1 ± 4.7			56	3.4 ± 7.3		
Active Duty Status								
Active Duty	190	3.3 ± 5.5	0.34	0.56	53	4.9 ± 7.5	2.79	0.10
Military Dependent	544	3.1 ± 5.2			264	2.8 ± 8.4		
Weight Cycling								
Non Weight Cycler	573	2.9 ± 4.9	7.90	0.01	155	2.3 ± 7.6	3.47	0.06
Weight Cycler	161	4.2 ± 6.6			162	4.0 ± 8.9		

	Simple Regressions					
	b ± Std Err	t	p value	b ± Std Err	t	p value
Pre-pregnancy BMI	0.24 ± 0.09	2.66	0.01	-0.19 ± 0.11	-1.73	0.09
First Trimester Gain	0.50 ± 0.07	7.22	<0.001	0.88 ± 0.10	8.47	<0.001
Second Trimester Gain	0.37 ± 0.07	5.65	<0.001	0.57 ± 0.11	5.08	<0.001
Third Trimester Gain	0.40 ± 0.05	7.30	<0.001	0.65 ± 0.10	6.31	<0.001
Maternal Height	0.02 ± 0.03	0.84	0.40	0.10 ± 0.06	1.56	0.12
Parity	0.23 ± 0.25	0.91	0.36	-0.45 ± 0.55	-0.83	0.41
Maternal Age	-0.11 ± 0.04	-3.06	0.002	-0.06 ± 0.09	-0.67	0.50

Table 9. Multivariate Regression Models of Weight Retention Stratified on Pre-pregnancy BMI

	Underweight/Normal Weight N=734			Overweight/Obese N=317		
	b	Lower CI	Upper CI	b	Lower CI	Upper CI
Pre-pregnancy BMI	0.16	-0.003	0.33	0.06	-0.14	0.27
First trimester gain	0.47	0.34	0.60	0.81	0.61	1.02
Second trimester gain	0.36	0.24	0.48	0.32	0.08	0.56
Third trimester gain	0.34	0.24	0.44	0.48	0.25	0.70
Maternal Height	0.01	-0.05	0.06	-0.15	-0.28	-0.03
Parity	0.47	-0.01	0.96	0.23	-0.82	1.28
Active duty (vs. military dependant)	-0.36	-1.20	0.48	-0.08	-2.30	2.13
Race (vs. white)						
Black	1.13	0.001	2.26	-2.19	-4.46	0.07
Asian	0.56	-0.57	1.69	-4.78	-7.88	-1.68
Hispanic	1.40	0.34	2.47	-1.19	-3.37	0.98
Maternal age	-0.07	-0.14	0.01	-0.01	-0.20	0.17
Weight cycler (vs. not)	0.62	-0.26	1.49	0.30	-1.37	1.96
Income (vs. moderate)						
Low	-0.52	-1.46	0.43	-0.66	-2.68	1.37
High	-0.78	-1.66	0.10	0.08	-2.14	2.30
Time	-0.01	-0.01	-0.01	-0.01	-0.01	0.001

Table 10. Association between covariates and weight retention by active duty status

	Active Duty Women N=243				Military Dependants N=808			
	N	Mean ± SD (kg)	F	p value	N	Mean ± SD (kg)	F	p value
Average Weight Retention	243	3.7 ± 6.0			808	3.0 ± 6.4		
Race			2.08	0.10			1.37	0.25
White	130	3.3 ± 5.4			468	3.2 ± 6.7		
Black	66	3.2 ± 6.2			79	3.7 ± 7.3		
Asian	12	3.8 ± 3.0			129	2.0 ± 4.9		
Hispanic	35	6.0 ± 7.9			132	2.9 ± 6.5		
Monthly Income			0.55	0.58			3.56	0.03
<$1501	125	3.6 ± 6.5			163	3.0 ± 7.6		
$1501-3000	38	4.6 ± 5.5			452	3.4 ± 6.4		
> $3000	80	3.4 ± 5.5			193	2.0 ± 5.2		
Weight Cycling			7.26	0.01			5.35	0.02
Non Weight Cycler	175	3.0 ± 5.3			553	2.6 ± 5.6		
Weight Cycler	68	5.3 ± 7.3			255	3.8 ± 7.9		

Simple Regressions

	b ± Std Err	t	p value	b ± Std Err	t	p value
Pre-pregnancy BMI	0.21 ± 0.11	1.89	0.06	-0.03 ± 0.04	-0.76	0.45
First Trimester Gain	0.76 ± 0.11	6.85	<0.001	0.65 ± 0.07	9.72	<0.001
Second Trimester Gain	0.52 ± 0.12	4.34	<0.001	0.42 ± 0.07	6.45	<0.001
Third Trimester Gain	0.69 ± 0.10	6.84	<0.001	0.44 ± 0.06	7.68	<0.001
Maternal Height	0.003 ± 0.05	0.05	0.96	0.06 ± 0.03	1.81	0.07
Parity	0.70 ± 0.64	1.09	0.28	-0.03 ± 0.27	-0.10	0.92
Maternal Age	-0.04 ± 0.07	-0.56	0.58	-0.11 ± 0.04	-2.54	0.01

Table 11. Multivariate Regression Models of Weight Retention Stratified on Active Duty Status

	Active Duty Women N=243			Military Dependants N=808		
	b	Lower CI	Upper CI	b	Lower CI	Upper CI
Pre-pregnancy BMI	0.07	-0.12	0.27	0.05	-0.04	0.14
First trimester gain	0.71	0.50	0.92	0.64	0.51	0.76
Second trimester gain	0.37	0.16	0.58	0.36	0.24	0.49
Third trimester gain	0.53	0.34	0.72	0.35	0.23	0.46
Maternal Height	-0.03	-0.12	0.07	-0.05	-0.12	0.01
Parity	0.11	-1.01	1.23	0.46	-0.06	0.99
Race (vs. white)						
Black	-0.40	-2.02	1.21	0.34	-1.06	1.73
Asian	1.97	-1.13	5.07	-1.09	-2.37	0.20
Hispanic	1.58	-0.35	3.51	0.19	-0.99	1.38
Maternal age	-0.03	-0.16	0.11	-0.06	-0.15	0.04
Weight cycler (vs. not)	0.52	-1.01	2.06	0.32	-0.61	1.26
Income (vs. moderate)						
Low	0.47	-1.35	2.29	-0.67	-1.72	0.39
High	0.04	-1.51	1.59	-0.88	-1.95	0.19
Time	-0.01	-0.02	-0.01	-0.01	-0.01	-0.004

Table 12. Multivariate Models of Weight Retention Stratified on Race

	White N=749		Black N=192		Asian N=172		Hispanic N=218	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Weight Cycler (vs. not)	1.58	0.61, 2.55	1.62	-0.71, 3.95	1.17	-0.91, 3.26	0.83	-1.17, 2.84
Pre-pregnancy weight (Kg)	0.01	-0.03, 0.05	-0.13	-0.20, -0.05	-0.10	-0.19, -0.02	-0.09	-0.16, -0.02
Maternal Height (cm)	0.02	-0.05, 0.09	0.01	-0.14, 0.15	0.08	-0.07, 0.24	-0.01	-0.16, 0.15
Maternal Age (years)	-0.09	-0.02, 0.004	-0.14	-0.34, 0.06	0.0003	-0.18, 0.18	0.08	-0.13, 0.29
Attended college (vs. less)	0.05	-0.90, 1.00	0.22	-1.65, 2.10	0.46	-1.47, 2.39	0.69	-1.07, 2.45
Parity 2+ (vs. 0/1)	-0.48	-1.77, 0.82	0.21	-2.28, 2.71	3.50	1.01, 5.99	2.38	-0.02, 4.79
Active duty (vs. military dependant)	-0.47	-1.61, 0.67	-1.33	-3.28, 0.62	1.99	-0.86, 4.84	1.66	-0.44, 3.77
Income (vs. medium)								
Low	0.33	-0.90, 1.55	-0.69	-2.82, 1.43	-1.22	-3.36, 0.92	-0.31	-2.14, 1.52
High	-0.51	-1.64, 0.62	-1.34	-4.26, 1.59	-1.87	-3.86, 0.12	-0.98	-3.53, 1.56
Amount of pregnancy weight gain (vs. recommended)								
Low	-0.97	-2.39, 0.46	-2.99	-5.82, -0.15	-0.67	-3.00, 1.65	-0.97	-3.34, 1.39
High	3.50	2.53, 4.55	2.03	-0.18, 4.23	4.22	2.46, 5.97	3.89	1.96, 5.82
Time (days)	-0.01	-0.02, -0.01	-0.02	-0.02, -0.01	-0.003	-0.01, .003	-0.01	-0.01, 0.002

Table 13. Multivariate Models of Weight Retention in Whites Stratified on Pre-pregnancy BMI

	<=26		>26	
	N=518		N=231	
	b	95% CI	b	95% CI
Weight Cycler (vs. not)	1.86	0.83, 2.90	1.22	-0.91, 3.36
Pre-pregnancy weight (Kg)	0.04	-0.04, 0.11	0.02	-0.08, 0.12
Maternal Height (cm)	-0.0003	-0.09, 0.09	0.01	-0.16, 0.19
Maternal Age (years)	-0.08	-0.18, 0.02	-0.15	-0.38, 0.08
Attended college (vs. less)	-0.12	-1.11, 0.87	0.55	-1.61, 2.71
Parity 2+ (vs. 0/1)	-0.26	-1.65, 1.12	-0.53	-3.27, 2.21
Active duty (vs. military dependant)	-0.67	-1.77, 0.43	0.34	-2.68, 3.35
Income (vs. medium)				
Low	-0.50	-1.78, 0.78	1.49	-1.25, 4.22
High	-0.79	-1.91, 0.33	-0.32	-3.19, 2.54
Amount of pregnancy weight gain (vs. recommended)				
Low	-1.04	-2.44, 0.35	0.40	-3.36, 4.16
High	2.57	1.58, 3.55	6.34	3.67, 9.00
Time (days)	-0.01	-0.02, -0.01	-0.01	-0.02, -0.001

OVERWEIGHT/OBESITY DEVELOPMENT IN WOMEN WITH NORMAL PRE-PREGNANCY BMI

- **Sample Descriptions**
- **Model Results**
  - In all
  - By active duty status

Table 14. Association Between Covariates And Postpartum Overweight/Obesity by Pre-pregnancy Body Size

		Postpartum BMI<=26		Postpartum BMI>26			
		N	%	N	%	$\chi 2$	p value
Overall	469		79	122	21		
Race						5.05	0.17
White	274		58	66	54		
Black	53		11	22	18		
Asian	73		16	14	11		
Hispanic	69		15	20	16		
Monthly Income						7.10	0.03
<$1501	81		17	23	19		
$1501-3000	230		49	73	60		
> $3000	158		34	26	21		
Active Duty Status						0.92	0.34
Active Duty	122		26	37	30		
Military Dependent	347		74	85	70		
Weight Cycling						9.95	0.002
Non Weight Cycler	365		78	78	64		
Weight Cycler	104		22	44	36		
		Simple Regressions					
	Mean		**SD**	**Mean**	**SD**	**F**	**p value**
Pre-Pregnancy BMI	22.4		1.5	24.3	1.2	165.94	<0.001
First Trimester Gain	2.0		2.3	3.3	3.6	25.07	<0.001
Second Trimester Gain	6.2		2.7	7.3	3.1	15.15	0.001
Third Trimester Gain	7.6		3.2	8.9	3.7	13.54	<0.001
Parity	0.6		0.8	0.6	0.9	0.05	0.83
Maternal Age	26.8		5.5	25.5	5.3	5.28	0.02

Table 15. Multivariate Logistic Regression Model of the Odds of Becoming Overweight/Obese Among Normal Weight Women At Month Six and After

	Normal Weight Women N=591		
	OR	Lower CI	Upper CI
First trimester gain	1.15	1.06	1.25
Second trimester gain	1.14	1.05	1.22
Third trimester gain	1.10	1.03	1.17
Parity	1.02	0.76	1.37
Active duty (vs. military dependant)	0.98	0.59	1.63
Race (vs. white)			
Black	1.66	0.86	3.20
Asian	1.06	0.53	2.11
Hispanic	1.40	0.76	2.61
Maternal age	0.98	0.93	1.03
Weight cycler (vs. not)	1.74	1.07	2.81
Income (vs. medium)			
Low	0.83	0.46	1.49
High	0.60	0.34	1.07
Time	1.00	1.00	1.00

Table 16. Association Between Covariates And Postpartum Overweight/Obesity by Active Duty Status

	Active Duty						Military Dependants					
	Postpartum BMI<=26		Postpartum BMI>26				Postpartum BMI <=26		Postpartum BMI>26			
	N	%	N	%	$\chi 2$	p value	N	%	N	%	$\chi 2$	p value
Overall	122	77	37	23			347	80	85	20		
Race					3.21	0.36					12.98	0.01
White	66	54	19	51			208	60	47	55		
Black	35	29	8	22			18	5	14	16		
Asian	8	7	2	5			65	19	12	14		
Hispanic	13	11	8	22			56	16	12	14		
Monthly Income					3.30	0.19					6.10	0.05
<$1501	15	12	8	22			66	19	15	18		
$1501-3000	57	47	19	51			173	50	54	64		
> $3000	50	41	10	27			108	31	16	19		
Weight Cycling					8.38	0.004					3.56	0.06
Non Weight Cycler	98	80	21	57			267	77	57	67		
Weight Cycler	24	20	16	43			80	23	28	33		
					Simple Regressions							
	Mean	**SD**	**Mean**	**SD**	**F**	**p value**	**Mean**	**SD**	**Mean**	**SD**	**F**	**p value**
Pre-Pregnancy BMI	22.5	1.6	24.2	1.1	37.24	<0.001	22.3	1.5	24.3	1.2	128.97	<0.001
First Trimester Gain	2.5	2.6	4.0	3.2	8.65	0.004	1.8	2.1	3.0	3.8	15.46	<0.001
Second Trimester Gain	6.4	2.8	7.5	2.7	4.34	0.04	6.1	2.7	7.2	3.3	10.42	0.001
Third Trimester Gain	7.8	2.8	9.1	4.0	4.98	0.03	7.6	3.3	8.8	3.6	8.54	0.004
Parity	0.4	0.6	0.3	0.5	1.17	0.28	0.7	0.9	0.8	1.0	0.17	0.68
Maternal Age	25.8	5.5	25.1	5.5	0.56	0.45	27.2	5.5	25.8	5.2	4.62	0.03

Table 17. Multivariate Logistic Regression Model of the Odds of Becoming Overweight Among Normal Weight Women At Month Six and After: Stratified on Active Duty Status

	Active Duty Women N=159			Military Dependant Women N=432		
	OR	Lower CI	Upper CI	OR	Lower CI	Upper CI
First trimester gain	1.17	0.99	1.37	1.16	1.06	1.28
Second trimester gain	1.12	0.96	1.31	1.13	1.04	1.23
Third trimester gain	1.07	0.93	1.24	1.11	1.03	1.20
Parity	0.53	0.22	1.24	1.08	0.78	1.49
Race (vs. white)						
Black	0.68	0.22	2.10	3.59	1.52	8.49
Asian	0.92	0.14	5.97	1.06	0.49	2.29
Hispanic	2.53	0.73	8.76	1.17	0.55	2.49
Maternal age	1.03	0.93	1.14	0.97	0.91	1.03
Weight cycler (vs. not)	2.99	1.20	7.50	1.37	0.76	2.45
Income (vs. medium)						
Low	1.34	0.39	4.63	0.71	0.35	1.44
High	0.59	0.19	1.88	0.62	0.30	1.26
Time	1.00	0.99	1.00	1.00	0.99	1.00

MULTIVARIATE RESULTS: PREGNANCY WEIGHT GAIN

Table 18. Multivariate Models of Pregnancy Weight Gain Stratified by Race

	White N=749		Black N=192		Asian N=172		Hispanic N=218	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Weight Cycler (vs. not)	2.60	1.61, 3.58	2.89	0.45, 5.32	2.29	0.16, 4.41	0.60	-1.45, 2.65
Pre-pregnancy weight (Kg)	-0.11	-0.14, -0.07	-0.12	-0.19, -0.04	-0.10	-0.19, -0.01	-0.15	-0.22, -0.07
Maternal Height (cm)	0.23	0.16, 0.31	0.17	0.02, 0.33	0.28	0.13, 0.44	0.34	0.19, 0.49
Maternal Age (years)	-0.12	-0.22, -0.02	0.03	-0.18, 0.24	-0.10	-0.29, 0.09	-0.003	-0.21, 0.21
Attended college (vs. less)	0.56	-0.42, 1.54	-0.02	-1.99, 1.96	-1.26	-3.23, 0.71	1.37	-0.41, 3.16
Parity 2+ (vs. 0/1)	-0.35	-1.69, 0.98	-1.46	-4.10, 1.18	-0.34	-2.88, 2.20	-0.60	-3.05, 1.85
Active duty (vs. military dependant)	1.47	0.31, 2.63	1.14	-0.89, 3.18	-0.05	-2.98, 2.89	2.31	0.21, 4.41
Gestational age (weeks)	0.65	0.35, 0.95	0.55	-0.08, 1.17	0.71	0.15, 1.27	0.57	0.004, 1.14
Income (vs. medium)								
Low	0.47	-0.79, 1.73	0.13	-2.11, 2.36	1.43	-0.75, 3.61	0.28	-1.59, 2.15
High	-0.45	-1.61, 0.70	-0.72	-0.378, 2.35	0.54	-1.50, 2.57	0.78	-1.77, 3.33

Table 19. Multivariate Models of Pregnancy Weight Gain in White Women Stratified on Pre-pregnancy BMI

	BMI <=26 N=518		BMI >26 231	
	b	95% CI	b	95% CI
Weight Cycler (vs. not)	2.44	1.43, 3.45	1.92	-0.26, 4.09
Pre-pregnancy weight (Kg)	0.04	-0.04, 0.12	-0.21	-0.31, -0.11
Maternal Height (cm)	0.06	-0.03, 0.14	0.47	0.30, 0.64
Maternal Age (years)	-0.16	-0.25, -0.06	-0.06	-0.29, 0.18
Attended college (vs. less)	0.50	-0.49, 1.49	0.58	-1.63, 2.78
Parity 2+ (vs. 0/1)	0.92	-0.45, 2.30	-2.32	-5.12, 0.47
Active duty (vs. military dependant)	0.83	-0.26, 1.91	3.11	0.04, 6.19
Gestational age (weeks)	0.70	0.41, 1.00	0.39	-0.31, 1.08
Income (vs. medium)				
Low	-0.38	-1.66, 0.89	2.42	-0.35, 5.20
High	-0.56	-1.67, 0.56	0.23	-2.69, 3.15